NOTE XXXII.

DESCRIPTIONS OF EARTHWORMS.

BY

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II [1]).

On *Eudrilus*-specimens from Surinam.

Among the worms of our collections I met with two specimens of the genus *Eudrilus*, kindly presented to our Museum by Mr. C. J. Heering from Surinam. The genus *Eudrilus* was named by Perrier [2]), who described three species: *E. Lacazii* (from Martinique), *E. decipiens* (from the Antilles) and *E. peregrinus* (from Rio Janeiro). Last year Mr. Beddard received from New Caledonia a dozen of earthworms, belonging to the same genus, which he named *E. Boyeri* [3]). The genus *Eudrilus*, though agreeing in many characters, viz.: the arrangement of the bristles, the presence of a muscular gizzard, the form of the vascular system, with *Lumbricus*, is distinguished from it by the remarkable structure of its genital organs. Beddard published a careful account of the anatomy of these organs [4]), which however differs in several respects from Perrier's earlier description;

1) For Part I see p. 97—106 and pl. 1 of this volume.

2) Nouv. Archiv. Muséum d'Hist. Nat. Vol. VIII, 1872, p. 71.

3) Proceed. Zoolog. Society London. 1886, p. 302.

4) Note on the ovaries and oviducts of *Eudrilus*: Zoolog. Anzeiger, IX Jahrg. 1886, p. 342.

therefore I thought it very interesting to examine if the structure of the genital organs in our specimens did correspond with his description. Moreover through the kindness of Mr. Layard I was able to dissect also some individuals of *E. Boyeri* Bedd. from New Caledonia.

The largest of our two Surinam-specimens measures 170 m.m. in length, the number of its segments being about 200. The cephalic lobe is club-shaped, impinging till the middle of the buccal segment. There is an annular girdle, occupying six segments, from the 13th to the 18th, quite like in *E. Lacazii* Perr. The female genital pores are situated on segment 14, in the series of the dorsal bristles, the male genital pores lie on segment 17, in the series of the ventral bristles; the last pores are rather large and surrounded by a ridge, which is radiately folded.

Our individuals are plainly intraclitelline, like *E. peregrinus*, *E. Lacazii* and *E. Boyeri*, and the assertion of Perrier, that *E. decipiens* should be postclitelline, its clitellum extending but from the 13th to the 15th segment, is undoubtedly a mistake as already suggested by himself.

The alimentary tract is furnished in the segments 10, 11 and 12, behind the gizzard, with three pairs of pouch-shaped glands, like in *E. Boyeri*; I have also been able to detect the series of glands on the dorsal wall of the intestine, in the posterior part of the body, mentioned by Beddard. There are three pairs of large lateral hearts in segment 8, 9 and 10, like in *E. Lacazii*; moreover an intestinal heart appears to be present in segment 11. Two pairs of seminal vesicles could be detected, occupying the segments 10, 11 and 12; with these are connected two pairs of vasa deferentia, whose ciliated rosettes are situated in segment 10 and 11. The two sperm-ducts of each side remained perfectly separated, running quite near each other, parallel with the intestine, till into the 17th segment; here they bend around the external side of the bursa copulatrix and open into the middle of a long, tubular, muscular

pouch, named by Beddard »prostatic gland." This organ, occupying about 7 segments, has nearly the same breadth over its whole length, only in its middle it is somewhat constricted and opens by a short, narrow duct on the cushion-shaped bursa copulatrix. Its wall has a nacreous appearance and consists of a thick external layer of longitudinal muscular fibres and a thinner internal layer of circular ones; this body, as stated by Perrier, though agreeing in its situation with the prostatic gland of other Lumbricidae, wants the glandular structure of that organ and therefore I believe it may by no means be identified with it. Since Beddard found the duct of this tube being continuous with the curved penis, it rather may be called ductus ejaculatorius. I also found the curious Y-shaped body, described by Perrier and Beddard, on the dorsal side of the bursa copulatrix.

The form of the male genital organs of our specimens quite agrees with the description and figure of these bodies in *E. Boyeri*, given by Beddard; on the contrary Perrier states, that the species he examined possessed only a single vas deferens on each side, and that this duct opened directly into the bursa copulatrix and not into the ductus ejaculatorius. I cannot suppose that there should exist such great differences, in respect of the structure of the male genital organs, between Perrier's and our West-Indian specimens, which quite agree with those from New Caledonia; and therefore I believe that Perrier has been mistaken in his observations.

The structure of the female genital organs is no less remarkable. They consist of a long, tubular pouch, the spermatheca, which is folded together in a longitudinal direction, parallel with the intestine, and opens unto the exterior by a muscular duct, situated perpendicularly on the remaining part of this body; with this efferent duct communicates another narrow, twisting tube, furnished at its aboral extremity with a small oval protuberance. In front of the last tube a small globular sac opens likewise

into the efferent duct of the spermatheca; according to Perrier this small sac represents the ovary.

In his paper in the Zoolog. Anzeiger Beddard not only fixed the attention on this remarkable continuity of the ovary and the spermatheca, but he also demonstrated by means of transverse sections of his New-Caledonian specimens, that not the globular sac does represent the ovary, as suggested by Perrier, but the oval protuberance at the extremity of the twisting tube, and that therefore in the genus *Eudrilus* the ovary is continuous with the oviduct. Though our specimens were not sufficiently preserved to allow the method of section-cutting, I have been able to confirm Beddard's statements, and I am quite agreeing with him, that Perrier has mistaken the relation of the ovary and the spermatheca. This suggestion is confirmed by some statements in the paper of Perrier himself, for as he says on page 75 »mais cet examen ne peut laisser aucun doute; ce sont là des ovaires etc.", on page 81 he says »c'est là très probablement l'ovaire; mais nous n'avons pas d'observations précises sur ce point", and the eggs of *E. peregrinus*, figured on pl. IV, fig. 76, have been found in a body, situated extérieurement and au dessous du tube entortillé and not in the globular sac, which lies intérieurement and en face du tube entortillé. From the foregoing considerations we may conclude, that, like our West-Indian specimens, with regard to the female genital bodies, agree with those from New Caledonia, it will also be the case with Perrier's specimens, and I am convinced that our worms belong to one of Perrier's species; perhaps his three species, differing from each other in very insignificant characters, represent only a single one. Considering that Beddard states of his *E. Boyeri* »which I cannot differentiate from those, described by Perrier" and »I am inclined myself to suspect, that the New-Caledonian specimens may have been accidently imported", and that, as I demonstrated before, there are no differences in respect of the genital organs, between his

and our West-Indian specimens, I cannot but think that they all belong to the same species, which I propose to call *E. decipiens*, the first described worm on which Perrier based the genus *Eudrilus*.

P.S. This note being already in press, I received from Mr. Beddard a paper, published in the Proceed. of the Royal Soc. of Edinburgh, Vol. XIII, which contains a more detailed description of the female generative apparatus, illustrated by several figures. In dealing with the morphology of these organs, he points out their strong resemblance with the female generative organs of *Hirudo*, a fact not agreeing with the results of recent investigators (Lang, Bourne a. o.), who regard the Hirudinea to be more closely allied to the Platyhelminthes than to the Annelida. The arguments of Mr. Bourne in favour of this view (Quart. Journ. Micr. Sc. 1884) however appear to me by no means conclusive, and I believe the Leeches to present several other points of affinity with the Oligochaeta. Their hermaphrodite condition, in connection with the presence of median generative pores, is not only a Platyhelminth character, as stated by Bourne; for all Oligochaeta are hermaphrodite, and *Perichaeta* has a single median female opening; their highly developed vascular system (especially of the Rhynchobdellidae) shows in its arrangement many points of resemblance with that of the Oligochaeta; they possess well-developed nephridia; they present a clitellum and have the practice of forming cocoons like the greater part of Oligochaeta. The presence of suckers, being an adaptive character produced by parasitism, seems of no great importance to me, and is also found in *Branchiobdella* among the Oligochaeta and in *Malacobdella* among the Nemertines.

On *Acanthodrilus Schlegelii* Horst and *ungulatus* Perrier. (Plate 4).

In vol. VI of this Journal, p. 103, I published a short description of *Ac. Schlegelii* from Liberia; having only a single badly preserved specimen at my disposal, my examination could be but very incomplete. Ever since our knowledge of the genus *Acanthodrilus* much increased owing to Beddard's careful account of the anatomy of three New-Zealand species. I was therefore very glad to receive through the care of my colleague Mr. Büttikofer another better preserved individual of the same species, now being able to fill up the gaps in my first description and to figure some of the principal details of the anatomy of this worm. I could also examine several specimens of *Ac. ungulatus* Perr., which Mr. Layard was kind enough to forward to me from New Caledonia [1]).

The specimen of *Ac. Schlegelii* measures about 350 m.m. in length, the number of its segments being 327. There

1) Beddard received also through the care of Mr. Layard several *Acanthodrilus*-specimens from New Caledonia, and though he states that these worms „may be identical with one or other of the two species (*Ac. ungulatus* and *Ac. obtusus*), first described from that region by Perrier," and that they agree in several characters viz. the position of the clitellum, the form of the penial setae, with *Ac. ungulatus*, nevertheless he figured them under the name of *Ac. Layardi* (Proc. Zool. Society, 1886, p. 168, pl. XIX). The most important differences between *Ac. ungulatus* and his specimens he points out, are the situation of the male genital pores and of the spermathecae; for Perrier stated that *Ac. ungulatus* has the male genital openings situated on the 18th and 20th ring, whereas in Beddard's and our specimens, like in the other known species of *Acanthodrilus*, they lie on the 17th and 19th segment. The spermathecae should be placed in segment 8 and 10, in stead of in segment 8 and 9, as found by Beddard and myself. I suppose that Perrier has only been mistaken in the number of the segments, 1° because he had but a single small specimen at his disposal, 2° because, through the state of contraction of the worm, it is often very difficult to determine the real number of a segment, as proved by Beddard himself, who corrects in this paper several statements he made before. Therefore I am convinced that the worms, sent to us by Mr. Layard, really belong to *Ac. ungulatus* Perr.

is no trace of a clitellum visible, as in the specimen described before. Each ring is marked in its middle by a transverse groove. My statement, that the cephalic lobe should extend over two segments, could not be confirmed. The first dorsal pore was observed between the 14th and 15th segment, one ring more backward as I found it in the first individual.

As for the appearance of the penial setae, situated next to the male genital pores in the angles of the depressed area on segment 17 and 19 (fig. 2), I may refer to my foregoing paper and to the figures 3 and 4. The female genital openings could not be detected.

In dissecting the worm I found the whole internal side of the body-wall to present a feltered appearance, like in *Perichaeta*, due to the presence of innumerable faint tubes, which, as already stated in my first paper, highly magnified have a strong resemblance with real segmental organs, though I have not been able to detect neither their external, nor their internal opening. On the contrary in *Ac. ungulatus* the nephridia are very obvious, as already stated by Beddard, and consist of a closely packed rosette of glandular tubes, communicating with the exterior by a large, thin-walled duct; they resemble much the nephridia of *Microchaeta Rappi* Bedd. [1]), but I tried in vain to find the internal funnel.

The vascular system of *Ac. Schlegelii* agrees much in its arrangement with that of *Ac. ungulatus* [2]). The dorsal vessel is a single tube, communicating with the ventral trunk by five large transverse hearts, situated in segment 10—13. The number of the pairs of these commissural vessels and that of the septa, separating them from each other, does not exactly correspond to that of the segments;

1) Beddard, On the anatomy and system. position of a gigantic earthworm from the Cape Colony; Transact. Zool. Society, Vol. XII, 1886, p. 64. — Benham, Studies on earthworms, Part II, Quart. Journal of Microsc. Science, Vol. XXVI, 1886, pl. XVI, fig. 21.

2) Proc. Zool. Society, 1886, pl. XIX, fig. 7.

I suppose that some of the muscular bands, radiating from the intestine to the body-wall, increased in size and thus grew similar to real septa. The first three pairs of transverse hearts arise simply from the dorsal trunk, but the two posterior pairs of them communicate also with the supra-intestinal vessel (v. typhlosolien); from the last vessel, in the region between the 2nd and 3rd pair of hearts, arises also a pair of lateral vessels (fig. 1, *lv*) which pass beneath the second transverse heart and, running forward along the side of the gizzard till the cephalic part of the body, supply the body-wall with several branches. In the 9th segment the lateral vessels of both sides communicate with each other by a transverse vessel, that passes beneath the middle of the gizzard.

In *Ac. ungulatus* the vascular system shows a curious difference in its arrangement from that of *Ac. Schlegelii*; for in that species the lateral vessels do not only arise from the underside of the intestine, where they unite in a single sub-intestinal vessel[1]), but in the 5th segment, on the limit of the pharynx and of the oesophagus, they communicate with each other by a transverse vessel, which passes above the intestine.

In *Ac. Schlegelii* I found two pairs of spermathecae in the 8th and 9th segment; they are oval pouches, without any diverticulum, opening unto the exterior by a short efferent duct, in the series of the internal bristle of the dorsal pair. Spermathozoa have not been observed therein.

In *Ac. ungulatus* the efferent duct of the spermatheca is furnished at its upper extremity with a slight protuberance, though, as rightly stated by Beddard, it is hardly so marked a diverticulum as figured by Perrier. This protuberance appears to be the seat of a strong secretion;

1) A curious mistake has crept in Beddard's figure of the vascular system of *Ac. Layardi* (loc. cit.); for according to this drawing the lateral vessels seem to arise from the dorsal side of the intestine, while in the text of his paper he says exactly: „these vessels pass beneath the intestine and unite to form a single subintestinal vessel."

for in transverse sections I found the epithelium in this portion of the duct differing very much from that in the remaining part. In stead of the epithelium, composed of high, columnar cells and covered by a cuticular membrane that lines the greatest part of the duct, I found in the protuberance an internal layer of cells, which not only want the cuticular membrane, but are also lower and broader, and which contain numerous large, clear bubbles of different shape, probably the products of secretion.

The curious sausage-shaped glandular bodies, observed by Beddard in some of his specimens of *Ac. Layardi*, next to the modified setae in the 8th segment, I have been unable to find, and the inconstancy of these structures makes it evident for me, that they have no great morphological importance. However I observed in the 7th and 8th ring several small, white vesicles, irregularly distributed and attached to the internal side of the body-wall. As to the function of these bodies, which I could not yet examine in transverse sections, I dare only say that I do not believe they represent a normal part of the organism of the earthworm, but I rather suppose they are strange organisms, perhaps belonging to some or other species of the Gregarinidae.

In the 11th and 12th ring — not in the 12th and 13th, as erroneously stated before — a pair of flat, faintly lobated bodies are to be found, attached to the posterior side of the anterior segment (fig. 1, *vs*). I was first inclined to take them for the real testes in an immature state, till I succeeded to detect in the 10th and 11th segment, exactly in front of the funnels of the vasa deferentia, a glandular body, attached to the posterior side of the anterior segment, on either side of the nerve-cord. These glands, not only in their situation but also in their form, correspond to the ovaries (see afterwards); they consist of a great number of digitately arranged lobes (fig. 5). Each lobe consists of polygonal cells, containing a granular protoplasma with a nucleus and a well-marked nucleolus

(fig. 6); these cells, which I suggest to be the male germinal cells (spermatospores) differed from the female germinal cells (oospores) by a less distinct nucleus.

In the bodies, attached to the anterior septum in the 11th and 12th ring, I found the spermatospores in a more advanced stage of development, showing the well-known mulberry-shaped masses; mature spermatozoa have not been observed. The organ itself has the same areolate structure as we know to exist in the seminal vesicles of other Lumbricina. I have no doubt therefore that the lobed bodies in the 11th and 12th segment represent the vesiculae seminales, originated by evagination and proliferation of the dissepiment, as is the case in *Lumbricus* and *Criodrilus*, according to the investigations of Bergh [1]) and Rosa [2]).

In *Ac. ungulatus* in the 11th and 12th segment also lobated glandular bodies are situated, much resembling those of *Ac. Schlegelii*, and probably representing the testes; they lie exactly in front of the ciliated rosettes of the sperm-ducts, at the internal side of the nephridia. It was only by means of transverse sections that I could find them out, for the septa in the genital region, especially those of the 11th segment, are strongly thickened and coalesced together. In all the specimens there are two pairs of vesiculae seminales, quite separated from each other. The anterior pair is attached to the anterior side of the 10th septum, and situated in the 10th segment; the posterior pair is fixed to the posterior side of the 11th septum, lying thus in the 12th segment.

From the foregoing considerations it may be concluded, that there exist in the species of *Acanthodrilus* real male genital glands (testes), morphological aequivalents of the ovaria, discharging their contents into the vesiculae seminales,

1) Untersuch. über Bau und Entw. der Geschlechtsorg. d. Regenwürmer; Zeitschr. f. Wissensch. Zoologie. Bd. XLIV, 1886, p. 304, pl. XXI.

2) Sul *Criodrilus Lacuum*, Memorie d. R. Accad. delle Scienze di Torino, Ser. II, Vol. XXXVIII, 1887.

quite as it is stated to be the case in *Lumbricus*, *Perichaeta*, *Microchaeta* and *Criodrilus*, according to the investigations of Hering, Bloomfield, Bergh, Benham, Rosa and myself. I am much inclined to believe that Beddard, in examining the New-Zealand species of *Acanthodrilus*, has confounded the vesiculae seminales with the testes; for his assertion, that the large racemose glands in the 11th and 12th segment cannot be homologous with vesiculae seminales, is based principally on their absolute independance of the vasa deferentia, whereas according to Ray Lankester's suggestion the seminal vesicles should originate as outgrowths of the vas-deferens funnels; afterwards Bergh however demonstrated that Lankester's supposition was erroneous and that the vesiculae seminales take their origine entirely independent of the funnels of the sperm-ducts, by evagination of the septum. It seems to me very probable that Beddard, in reexamining his specimens, will find the real testes; perhaps the peculiar glands, homologous (?) with ovaries, t,t' in the woodcut fig. 3 in his paper, will appear to represent them.

Ac. Schlegelii has the ovaries in segment 13, i. e. next to that which contains the posterior pair of seminal vesicles; they are attached to the anterior septum, next to the ventral middle line. The ovaries have the appearance of a flattened body, consisting of numerous radiately distributed lobes. Each lobe is not unlike to the single ovary of *Lumbricus*. Its basal portion, that is attached to the septum, consists of a mass of granular protoplasma containing nuclei; to the distal extremity of the lobe the eggs are more and more recognisable, and its free end contains usually one or two large ripe eggs, enclosed in a follicle, which are on the point of becoming free. In *Ac. ungulatus* the ovaries have also been found in the 13th segment, and that they could escape the sharp scrutinizing eye of Beddard may be occasioned by their being situated close to the median side of a nephridium, whose radiating tuft of loops to the naked eye shows much resem-

blance with the digitate lobes of the ovary. Examining them with a high power, I found the ovaries of this species consisting of numerous loops of blood-vessels and a germinal epithelium, containing eggs in all stages of development, attached to their wall.

EXPLANATION

OF

Plate 4.

Fig. 1. *Ac. Schlegelii* Horst; general view of the contents of the body-cavity: *gl.* intestinal coeca; *lv.* lateral vessel; *o.* ovary; *pr.* prostate gland; *r.* ciliated rosette of the vas deferens; *sp.* spermatheca; *t.* testes; *vs.* vesicula seminalis.

Fig. 2. Genital region, from the ventral side, to show the depressed area, with the male genital pores on segments 17 and 19.

Fig. 3. *a.* Penial setae; *b.* ordinary setae. × 16 diam.

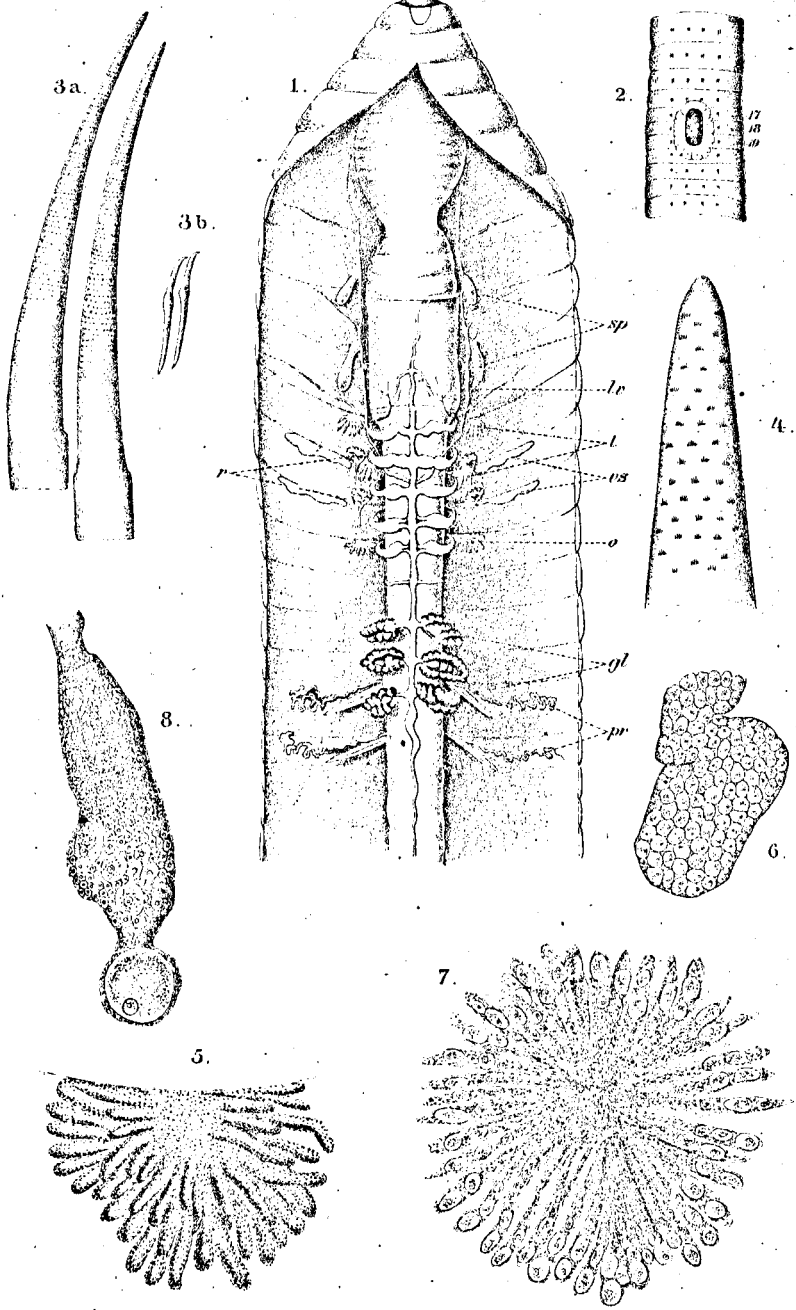
Fig. 4. The free extremity of a penial seta, highly magnified, to show the small pitts on its surface.

Fig. 5. Testis. × 36 diam.

Fig. 6. A single testis-lobe, more highly magnified.

Fig. 7. Ovary. × 36 diam.

Fig. 8. Lobe of the ovary. × 90 diam.



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Acanthodrilus Schlegelii *Horst.*